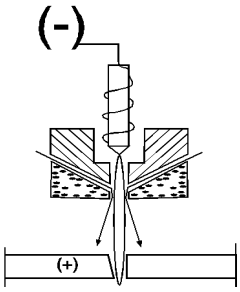
Applied Technology: Plasma Arc



Credit: Philip Schmidt, University of Texas, Austin

Concept

A plasma is an ionized gas which has become an electrical conductor. Gas is passed through an electric arc, thus reaching approximately 5500 ^{o}C. This is known as a "thermal" or "hot" plasma. *See "Plasma (Ion) Nitriding" for "cold plasma" applications such as semiconductor etching.* Containing tremendous energy, thermal plasmas produce very fast and precise melting and cutting of metals.

.

Applications

- Melting; metals, ceramics, and glasses
- Reduction; ores
- Ladle Refining; steel
- Surface Treating; wear and corrosion resistance
- Welding; metals
- Cutting; metals

Technologies Replaced

- Cutting Metals by Mechanical or Laser
- Welding by Conventional Arc, Laser, or Gas
- Melting Metals, Ceramics, and Glasses by Conventional Arc or Fossil Fuels
- Heat Treating Metal Surfaces

Wastes Reduced

- Metal Cutting Fluids and Wastewater (machining)
- Scale and Slag (welding)
- Wastewater and Emissions (heat treating)
- Material Removal

Potential in Manufacturing

Indust	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*
Food	20	LOW	Lumber	24	LOW	Chem	28	LOW	Stone	32	MED	**Elect**	**36**	**HI**
Tobac	21	LOW	Furn	25	LOW	Petrol	29	LOW	**Pmetal**	**33**	**HI**	**Transp**	**37**	**HI**
Textile	22	LOW	Paper	26	LOW	Rubber	30	LOW	**MetFab**	**34**	**HI**	Instr	38	LOW
Apparel	23	LOW	Printing	27	LOW	Leather	31	LOW	**Mach**	**35**	**HI**	Misc	39	MED

Credits: **: Dr. Philip Schmidt and Dr. F.T. Sparrow;**
Unimar Group, Ltd; The Electrification Council; Electric Power Research Institute

Plasma Arc ***continued***

Technology Advantages

- High Productivity; due to high speed of energy deposition
- Small Equipment Size
- Enhanced Flexibility; automation
- Cuts and Melts Difficult Materials
- Eliminates or Reduces Oxidation (due to controlled atmosphere)
- Process Control Simplification

Technology Disadvantages

- High energy-Density Processes; leave small margin of error, require careful control

Typical Costs

Capital Costs	O & M Costs	Potential Payback
$1k - $50k for cutting and spray; similar to conventional arc and oxyfuel-based systems; about 1/10 cost of laser	application dependent; typical operating cost, including power, labor, and inert gases of plasma cutting for 6 mm (¼") steel plate is about $0.23/m ($0.07/ft); electrode replacement every 2-8 hours ($15-$40/set) takes only a few minutes	< 1 year; small plasma cutting systems require little capital investment
>$1 million; for large melting systems		< 1 year - 2 years or more; large melting systems are very capital intensive

Installations

Case A - Four shop workers using a mechanical cutting system in a plant producing custom fabricated AC ductwork supplied 30 field installers. The plant needed higher productivity and the metal cutting operation was the bottle neck. Laser cutting was investigated but the capital cost was too high and the laser precision was not necessary.

A plasma cutting system was installed. Now 2 shop workers supply 50 field installers. The installed capital cost was $130,000 and payback was about 1 year.

Case B - Plasma heaters are now used in over a dozen steel mills around the world for maintaining precise control of steel temperature as it passes down a tundish to a continuous caster. These units range in power rating from 350 kW to about 2.5 MW. Steel temperature entering the caster is controlled to a precision of 1 ^{o}C. The systems produce higher yields, better refractory life, and improved steel quality.

Major Vendors

Plasma Arc

Century Manufacturing Company
(cutting, welding equipment)
9231 Penn Avenue
Bloomington, MN 55431
(800) 328-2921

Hard Face Alloy
(spray coating equipment)
8351 Securia Way
Santa Fe Springs, CA 90670
(310) 945-5477

Hypertherm Inc.
P.O. Box 5010
Hanover, NH 03755
(800) 643-0030

Thermal Dynamics
Industrial Park #2
West Lebanon, NH 03784
(603) 298-5711

Weldcraft Products, Inc.
119 E. Graham Plaza
Burbank, CA 91502
(818) 846-8181

This list of vendors of the indicated technology is not meant to be a complete or comprehensive listing. Mention of any product, process, service, or vendor in this publication is solely for educational purposes and should not be regarded as an endorsement by the authors or publishers.

Index to EPRI DOCUMENTS

Plasma Arc

Plasma Arc Cutting, EPRI CMF TechCommentary, Vol 4, No 5, 1987

Plasma Cutting, EPRI CMF TechApplication, Vol 1, No 14, 1991

Plasma Arc Technology, EPRI CMP TechCommentary, No 76, 1992

Submerged Arc Furnaces, EPRI TechCommentary, TC-106672 (CMP-109), 1996

Plasma Cupola Iron Melting, EPRI TechApplication, TA-106909 (CMP-111), 1996

Plasma Tundish Heating, EPRI CMP TechApplication, CMP-046, 1989

Plasma Tundish Heating Saves Cold Starts During Casting, EPRI TechApplication, TA-105689 (CMP-105), 1995

This information is designed to help you determine **potential** applications for the technology. You are encouraged to contact one of the listed vendors or a consultant for details and pricing.

This manual is not intended as a recommendation of any particular technology, process, or method. Mention of trade names, vendors, or commercial products do not constitute endorsement or recommendation for use. It is offered for educational and informational purposes and is advisory only.

For reprints write to:
TVA Economic Development
400 West Summit Hill Drive
Knoxville, TN 37902-1499

E-Mail:
sjhillenbrand@tva.gov

Developed with funding from the U.S. Environmental Protection Agency - Center for Environmental Research Information